Surface and Interface Analysis

(*SIA. Surf. interface anal.*)

VOLUME 12 ISSUES 1–12 JULY 1988

Proceedings of the European Conference on
Applications of Surface and Interface Analysis
19–23 October 1987, Fellbach, near Stuttgart, FRG

CONTENTS

Preface/Editorial i

Opening Speeches iii

SECTION 1. TECHNIQUE DEVELOPMENTS

High Spatial Resolution Analytical Electron Microscopy Studies on the Co/CeO_2 System 3
C. COLLIEX, D. UGARTE, Z. L. WANG, M. GASGNIER AND V. PAUL-BONCOUR

Differential Reflectometry and its Application in Materials Science 11
R. E. HUMMEL

Surface Characterization by Means of Photoemission of Adsorbed Xenon (PAX) 15
K. WANDELT, K. MARKERT, P. DOLLE, A. JABLONSKI AND J. W. NIEMANTSVERDRIET

Automated Interface Recognition in Auger Sputter Depth Profiling 21
M. D. HILL

LMIS–SIMS Studies of Oxide Scales 27
D. P. MOON

Interface Analysis Using Elastic Scattering in the Transmission Electron Microscope: Application to the Oxidation of Silicon 35
F. M. ROSS AND W. M. STOBBS

Experimental Detection Limits in Scanning Auger Microscopy at High Lateral Resolution 45
J. CHAZELAS, J. CAZAUX, G. GILLMANN, J. LYNCH AND R. SZYMANSKI

Simple Angle-resolved Auger Electron Spectroscopy System—Effective Rule for Measurement and Tests of Possibilities 49
A. MRÓZ, S. MRÓZ AND M. ZAGÓRSKI

TOFS–SIMS Analysis of the Surface of Insulators. Examples of Chemically Modified Polymers and Glass 53
J. LUB, P. N. T. VAN VELZEN, D. VAN LEYEN, B. HAGENHOFF AND A. BENNINGHOVEN

Extended Abstracts

Electron Stimulated F^+ Desorption: a Sensitive Method for Detection of Fluorine 59
C. XUEKANG AND F. CHUIZHEN

A High Resolution Scanning Tunnelling Microscope 59
M. P. COX

Real-time Imaging of Analyzed Areas in Surface Analysis 60
L. GRAZULIS, D. H. TOMICH, M. F. KOENIG AND J. T. GRANT

Electron Optical Methods for Microanalysis of Surfaces 61
H. SEILER

SECTION 2. QUANTIFICATION

Ion Bombardment Effects on the Near-surface Composition During Sputter Profiling 65
N. Q. LAM

Transfer and Treatment of AES, XPS and SIMS Data with a Network Computer Station 78
H. J. MATHIEU, S. MISCHLER, A. VOGEL, A. SEILER AND G. RIEDL

SIANDQ 12(1–12) 1–578 (1988)
ISSN 0142–2421

CONTENTS

Redeposition in AES Sputter Depth Profiling of Multilayer Cr/Ni Thin Films 83
A. ZALAR AND S. HOFMANN

Matrix Dependence of Elastic Scattering Effects in Quantitative AES and XPS 87
A. JABLONSKI, B. LESIAK, H. EBEL AND M. F. EBEL

Noble Gas Depth Profiles in Amorphous TiO_2 Films after Sputtering 93
M. WOLFF AND J. W. SCHULTZE

Simulation of the LMM Auger Spectra of Copper 99
P. DUBOT, D. JOUSSET, V. PINET, F. PELLERIN AND J. P. LANGERON

Quantitative AES: The Establishment of a Standard Reference Spectrum for the Accurate Determination of Spectrometer Transmission Functions 105
G. C. SMITH AND M. P. SEAH

Thickness Determination of Oxide Layers on Spherically-shaped Metal Powders by ESCA 110
L. NYBORG, A. NYLUND AND I. OLEFJORD

XPS Analysis of Oxides 115
E. PAPARAZZO

Surface Characterization by Energy Distribution Measurements of Secondary Electrons and of Ion-induced Electrons 119
H. E. BAUER AND H. SEILER

Quantitative Surface Chemical Analysis of Au–Cu Alloys with AES 125
K. YOSHIHARA, R. SHIMIZU, T. HOMMA, H. TOKUTAKA, K. GOTO, M. UEMURA, D. FUJITA, A. KUROKAWA, S. ICHIMURA, C. OSHIMA, M. KURAHASHI, M. KUDO, Y. HASHIGUCHI, Y. FUKUDA, T. SUZUKI, T. OHMURA, F. SOEDA, K. TANAKA, A. TANAKA, T. SEKINE, Y. SHIOKAWA AND T. HAYASHI

Crystalline Effects in Single Crystal and Highly Textured TiN_x Films 131
C. STRANDBERG AND A. J. PERRY

Quantitative Surface Analysis by XPS and XAS 137
H. EBEL, M. F. EBEL AND H. KROCZA

Ion Beam Induced Roughness and its Effect in AES Depth Profiling of Multilayer Ni/Cr Thin Films 144
Á. BARNA, P. B. BARNA AND A. ZALAR

Quantitative AES Analysis of Ti Silicide and Co Silicide Films 151
W. D. CHEN, H. BENDER, W. VANDERVORST AND H. E. MAES

Quantitative Auger Electron Spectroscopy of $Al_xGa_{1-x}As$ Layers and Superstructures Grown by MBE 156
W. D. CHEN, H. BENDER, A. DEMESMAEKER, W. VANDERVORST AND H. E. MAES

Extended Abstracts

Simulation of Electron/Solid Interaction and Application to Quantitative Analysis by Electron Spectroscopies 161
S. ICHIMURA, D. ZE-JUNG AND R. SHIMIZU

VAMAS Surface Chemical Analysis Standard Data Transfer Format 161
W. A. DENCH, L. B. HAZELL, M. P. SEAH AND THE VAMAS COMMUNITY

Signals, Noise, Reference Signal-to-Noise Ratios and a Standard Figure-of-Merit for Auger Electron Spectrometers 164
M. P. SEAH, C. P. HUNT AND W. A. DENCH

Ion Implantation for Preparation of Standards for Surface and Trace Analysis in Metals 165
G. FRIEDBACHER, A. VIRAG, M. GRASSERBAUER, H. BUBERT, L. PALMETSHOFER, P. WILHARTITZ, H. M. ORTNER, P. RÖDHAMMER AND W. RITTER

Non-destructive Centroid Depth Determination of Analyte Profiles using Intensity Attenuation in Photon and Electron Spectroscopies 167
W. H. GRIES

Appearance Potential Spectroscopy of Layered Materials: a Model 169
L. ECKERTOVÁ

Chemical Shifts Determination by Ion-induced AES in Some Oxides 170
Y. ZHENJIANG, Q. WEIJIANG AND F. CHUIZHEN

Molecular Surface Analysis using Low Energy Electron-induced X-ray Emission Spectrometry (LEEIXS): a Quantitative Approach 171
F. GAILLARD AND M. ROMAND

The Energy Dependence of Attenuation Lengths in Elements 172
H. EBEL, M. F. EBEL, P. BALDAUF AND A. JABLONSKI

Data Chart for X-Ray Excited Auger Electron Spectroscopy 173
X. YU

Excitation of KLL-Auger Spectra by White X-Radiation 175
M. F. EBEL, H. EBEL, J. WERNISCH, H. KROCZA AND P. ETTMAYER

SECTION 3. METALLURGY

Atom-probe Analysis of Grain Boundary Segregation 179
H. NORDÉN AND H. O. ANDRÉN

An Energy-resolved Electron Stimulated Desorption (ESD) Study of Oxygen-exposed Ag(110) 185
G. R. CORALLO, G. B. HOFLUND AND R. A. OUTLAW

Grain Boundary Segregation in Inconel 600 191
P. CACERAS, B. RALPH, G. C. ALLEN AND R. K. WILD

Tinplates and Tin/Chromium Interfaces Studied by Electron Spectroscopies 198
F. R. LAURITSEN, J. ONSGAARD AND H. VINTERNES

Analytical Study on the Fe/Ti Interface in Titanium-clad Steels 203
F. KUROSAWA

Surface Layers on Fe Formed During Plasma Nitriding Studied by XPS and Reflection EELS 211
I. LE R. STRYDOM, A. WELLS AND N. P. FERREIRA

Surface Segregated Boron Nitride on a Fe–Si Alloy: Thermal Oxidation and Related Segregation Phenomena 218
P. HUMBERT, M. ESSOUNI AND A. MOSSER

Extended Abstracts

Grain Boundary Segregation of P in Ni and Ni–20% Cr and Its Effect on Tensile Behaviour 223
J. KÜPPER, H. J. GRABKE AND H. VIEFHAUS

Formation of Compounds by Segregation and Gas–Metal Reactions on Iron Surfaces 224
H. J. GRABKE, C. UEBING AND H. VIEFHAUS

Environmental and Segregation Effects on Crack Nucleation and Propagation along Defined Boundaries in Bicrystals 225
H. VEHOFF

Interface Analysis of Aluminium Reinforced Carbon Fibre by SAM 226
L. YUNQI AND Y. ZHENJIANG

AES Investigations on Superconducting A-15 Phase Compound Materials 227
E. W. SEIBT

Magnesium Enrichment on the Surface of Aluminium Foils 228
H. EBEL, M. F. EBEL, J. WERNISCH AND J. PINGITZER

Surface Characterization of Rapidly Solidified Al–Mn and Al–Fe Alloys 229
A. CSANÀDY, I. BERTÓTI, M. MOHAI, S. PERCEL AND B. ALBERT

SECTION 4. CATALYSIS

Analysis of *in situ* Prepared Surfaces of an Iron Oxide Based Dehydrogenation Catalyst 233
M. MUHLER, R. SCHLÖGL AND G. ERTL

Supported Rhodium Catalysts. Support Effects on State and Dispersion of the Rhodium 239
M. I. ZAKI, B. TESCHE, L. KRAUS AND H. KNÖZINGER

XPS and TPR/TPO Study of the Behaviour of Rhodium Particles Supported on TiO_2 247
A. MUÑOZ, G. MUNUERA, P. MALET, A. R. GONZÁLEZ-ELIPE AND J. P. ESPINÓS

Characterization of Supported Pd Catalysts 253
H. PAPP AND P. KAMP

Oxygen-containing Species on Amorphous $Fe_{80}B_{20}$ and $Fe_{40}Ni_{40}B_{20}$ Alloys During Chemisorption of CO and H_2 257
Z. ZSOLDOS, Z. SCHAY AND L. GUCZI

Surface Characterization of the Deactivation of Alumina Catalysts used for COS Synthesis 262
G. MINK, I. BERTÓTI, L. NÉMETH, G. GÁTI, M. MOHAI AND T. SZÉKELY

Equilibration Processes at NiO Surfaces 269
J. NOWOTNY, M. SLOMA AND W. WEPPNER

Extended Abstracts

Surface Characterization and Redox Behaviour of Iron-containing Bismuth Molybdovanadates by X-ray Photoelectron Spectroscopy 273
D. GAZZOLI, A. ANICHINI, S. DE ROSSI, M. LO JACONO, P. PORTA AND M. VALIGI

Auger Investigations of Pd Films on SnO_2 and ZnO Single Crystals 274
R. HUCK, D. KOHL AND G. HEILAND

Surface Characterization of Chlorine Treated γ-Al_2O_3 Catalysts 275
R. RÉTI, I. BERTÓTI, G. MINK, T. SZÉKELY AND G. VARSÁNYI

SECTION 5. ELECTRONICS

Molecular Beam Epitaxy of Semiconductor Interfaces and Quantum Wells for Advanced Optoelectronic Devices 279
K. PLOOG

XPS and AES Studies of Halofluorocarbon Plasma Etched Surfaces 288
E. OCCHIELLO AND F. GARBASSI

The Interaction of Group IB Metals with van der Waals Faces of Semiconducting Metal Dichalcogenides 293
W. JAEGERMANN, F. S. OHUCHI AND B. A. PARKINSON

An Energy-resolved, Electron-stimulated Desorption Study of Hydrogen from Cleaned and Oxidized Si(100) 297
C. F. CORALLO AND G. B. HOFLUND

Applications of *in situ* SIMS During Processing of Electronic Materials 303
A. P. WEBB AND J. A. SMITH

SiO_2 in 6 : 3 (Stishovite) and 4 : 2 Co-ordination—Characterization by Core Level Spectroscopy (XPS/XAES) 309
J. FINSTER

XPS Investigation of Oxide Films on InP(100) 315
A. HOFMANN, P. STREUBEL AND A. MEISEL

Extended Abstracts

Core-level Binding Energy Shifts on InP Surfaces Induced by Sputtering and Annealing 321
R. N. S. SODHI, W. M. LAU AND S. I. J. INGREY

Thin Si_3N_4 Films on Si Wafers 322
M. F. EBEL, H. EBEL, H. BUCHNER AND R. CHABICOVSKY

XPS Investigation on Amorphous Silicon Nitride (a-SiN*x*) Chemical Structure 323
G. M. INGO, N. ZACCHETTI, D. DELLA SALA AND C. COLUZZA

SIMS Analysis of the 4 Megabit DRAM Trench Wall 324
H. ZEININGER, R. V. CRIEGERN AND S. RÖHL

Damage Production in Hydrogen-implanted Silicon 325
J. LAHTINEN, A. VEHANEN, E. PUNKKA, P. HAUTOJÄRVI, J. KEINONEN, M. HAUTALA, E. RAUHALA, V. KARTTUNEN, A. KURONEN AND J. RÄISÄNEN

The Hole Concentration on Oxygen Sites in the High T_c Superconductor $YBa_2Cu_3O_{7-x}$ 326
P. STEINER, S. HÜFNER, V. KINSINGER, I. SANDER, B. SIEGWART, H. SCHMITT, R. SCHULZ, S. JUNK, G. SCHWITZGEBEL, A. GOLD, C. POLITIS, H. P. MÜLLER, R. HOPPE, S. KEMMLER-SACK AND C. KUNZ

SECTION 6. THIN FILMS AND SEMICONDUCTORS

Selective Oxidation and Chemical State of Al and Ti in (Ti, Al)N Coatings 329
S. HOFMANN AND H. A. JEHN

RBS and AES Depth Profiles of Pd Deposited on Si after Annealing at Different Temperatures 334
M. CLEMENT, J. M. SANZ, A. CLIMENT AND J. M. MARTÍNEZ-DUART

Investigation of Cross-contamination During Si-implantation in GaAs with SIMS 339
M. MEURIS, W. VANDERVORST AND H. E. MAES

XPS and SIMS Characterization of Metal Oxide/Amorphous Silicon—Carbon Interfaces 344
A. EICKE AND G. BILGER

Extended Abstracts

Textures and Surface Structures of Thin Silver Films 351
R. GEBHARDT, H. GEIGER, P. WISSMANN AND H. ZITZMANN

Study of the Redistribution of High Dose Sb and P Implants in Silicon by Combination of SIMS and TEM 352
G. STINGEDER, M. GRASSERBAUER, P. PONGRATZ, W. KUHNERT, I. WIPPEL, P. SKALICKY, E. GUERRERO AND H. PÖTZL

ARXPS Study of NbN Sputter Deposition on MgO and Nb_2O_5 : Damage, Epitaxy and Growth 354
J. HALBRITTER

Detection of Substrate-related Species During Depth Profiling of a-Si : H Films with SIMS 355
J. HERION, W. BEYER AND H. WAGNER

Analysis of the Tantalum Segregation in Films of Non-stoichiometric $TaSi_x$ 356
W. HÖSLER, W. RUDNICK, H. GÖBEL, K. GRÄBER, T. HILLMER AND A. MITWALSKY

Surface Analytical Studies of Carbon Layers on Molybdenum for Fusion Experiments 357
A. VIRAG, W. JÄGER, G. FRIEDBACHER, M. GRASSERBAUER, F. WAELBROEK, J. WINTER, U. LITTMARK, H. NICKEL AND E. KNY

Surface Analysis of Thin Carbon Films used as Supports for Electron Microscopy 359
R. SCHLÖGL, B. TESCHE AND G. WEINBERG

SECTION 7. CORROSION

Combined Surface Analytical and Electrochemical Studies for Corrosion Research 363
H.-H. STREHBLOW

EXAFS Study of Passive Films on Ni and Ni–Mo Alloy Electrodes 380
L. BOSIO, R. CORTÈS, P. DELICHÈRE, M. FROMENT AND S. JOIRET

Oxygen Interaction with Mo(100) Studied by XPS, AES and EELS 385
E. MINNI AND F. WERFEL

The Influence of Y on the Structure and Growth Mechanism of Alumina Scales 391
P. A. VAN MANEN, E. W. A. YOUNG, D. SCHALKOORD, C. J. VAN DER WEKKEN AND J. H. W. DE WIT

Sulphide Formation on the Surface of Binary Ag–Pd Alloys Studied by XPS, AES, SEM/EDX 397
J. HAUTANIEMI, M. HEINONEN, J. JUHANOJA AND E. SUONINEN

Surface Reactions During Rapid Solidification and Handling of Al5Mn2.5Cr Powders 401
I. OLEFJORD AND A. NYLUND

Ellipsometric Studies on the Interaction of Oxygen with Thin Copper Films at 460 K 407
R. SCHMIDT AND P. WISSMANN

Characterization by XPS and AES of Oxide Films Formed on Stainless Steel 304 under Various PWR Conditions 412
S. B. COULING AND L. S. WELCH

Study of Thin Corrosion Films by *in situ* Raman Spectroscopy Combined with Direct Observation of Nuclear Reactions 419
P. DELICHERE, A. HUGOT-LE GOFF AND S. JOIRET

Quantitative Auger Analysis of Passive Films Formed on Stainless Steels 424
G. LORANG, F. BASILE, M. DA CUNHA BELO AND J.-P. LANGERON

Extended Abstracts

The Investigation of Passive Films on Iron–Chromium Alloys by AES and XPS 429
S. MISCHLER, H. J. MATHIEU AND D. LANDOLT

Complete Mass Balance of Selective Metal Oxidation of High-temperature Alloys Using EPMA Methods 429
L. MALDONADO-LOPEZ, H. GRÜBMEIER, A. NAOUMIDIS AND H. NICKEL

The Phase Composition of the Passive Layer on Iron 430
W. MEISEL, U. STUMM AND P. GÜTLICH

Quantitative Depth Profiles of Lithium-corroded Vanadium and Vanadium Alloys by Auger Electron Spectroscopy 431
E. NOLD, CHR. ADELHELM AND H. U. BORGSTEDT

Study of the Natural and Passive Oxide Films Formed on Ni–Mo Single Crystal Alloys by Ion Channelling and Nuclear Microanalysis 433
P. MARCUS, M. MOSCATELLI, C. COHEN, J. GYULAI, D. SCHMAUS AND M. SOTTO

The Use of Static and Imaging SIMS for the Study of Corrosion of Galvanized Steel under Paint Coatings 434
W. J. VAN OOIJ AND A. BROWN

Reflectance Spectroscopy (UC-Vis-NIR, FTIR) of Oxide Films. Oxide Layers on Copper and Nickel 436
M. LENGLET, J. M. MACHEFERT, J. ARSENE, P. LETERRIBLE, J. M. WELTER, M. LECALVAR AND R. FONTAINE

Oxidation of NiCr and NiCrFe Alloys at Room Temperature 437
J. STEFFEN AND S. HOFMANN

XPS Studies on the Surface Thermal Modifications of Tin Oxides 438
E. PAPARAZZO, G. FIERRO, G. M. INGO AND N. ZACCHETTI

Quantitative Determination of Chromium in Conversion Layers on Aluminium by Use of Calibration Samples 439
H. BUBERT, R. P. H. GARTEN, G. STINGEDER AND U. WÄTJEN

The Effect of Lead and Iron Ions on Copper Electrodeposited from a Pyrophosphate Bath 441
D. DE FILIPPO, L. DESSÌ AND A. ROSSI

XPS and AES Studies of the Reduction of Pd(II) and Au(III) on Sulphide Minerals 443
M. M. HYLAND AND G. M. BANCROFT

SECTION 8. POLYMERS

ESCA and REELS Characterization of Electrically Conductive Polyimide Obtained by Ion Bombardment in the keV Range 447
G. MARLETTA, C. OLIVERI, G. FERLA AND S. PIGNATARO

A Quantification and Investigation of Surface Microporosity in Carbon Fibres Using Labelling and XPS 455
P. DENISON, F. R. JONES AND J. F. WATTS

Identification of Synthetic Metals from the Shape of the Carbon KLL Spectra by the Pattern Recognition Method 461
B. LESIAK, A. JABLONSKI, M. ZAGORSKA AND A. JOZWIK

Extended Abstracts

Surface Characterization of Intraocular Lenses by ESCA 469
B. LINDBERG, P. MÅNSSON, E.-L. HARTMAN AND Å. ÖHRLUND

Surface Effects on a Polysulphone Induced by X-Ray-, Electron-, or Ion-beams 470
A. TÓTH, I. BERTÓTI, T. SZÉKELY, G. MARLETTA, S. PIGNATARO AND P. KESZLER

Analysis of the Yeast Cell Surface by X-ray Photoelectron Spectroscopy 471
D. E. AMORY, M. J. GENET AND P. G. ROUXHET

A Study of Polyester Model Compounds by MS, Quadrupole SIMS, ToF SIMS and LMMS 472
K. D. BRONSEMA, M. E. F. BIEMOND, F. J. M. VAN DE VEN, A. BROWN, P. HUMPHREY AND J. ECCLES

SECTION 9. ADHESION

Adhesion of Polymers to Metals: A Review of the Results Obtained Studying a Model System 475
C. BOIZIAU AND G. LECAYON

Study of the Al/PET Interface in Relation with Adhesion 486
Y. DE PUYDT, P. BERTRAND AND P. LUTGEN

Surface Characterization of AISI 304L Stainless Steel Subjected to Various Prebonding Treatments. Correlation with Adhesion Measurements 491
F. GAILLARD AND M. ROMAND

The Application of Surface Analysis to Studies of the Environmental Degradation of Polymer-to-metal Adhesion 497
J. F. WATTS

CONTENTS

Extended Abstract

Adhesion of Copper and Chromium Films to Polyimide Studied by Static SIMS of the Interface 505
W. J. VAN OOIJ, R. H. G. BRINKHUIS AND J. M. PARK

SECTION 10. CERAMICS

Analysis of Ion Implanted Ceramics. Studies of Iron Implanted MgO and Al_2O_3 509
G. MAREST

SAM Analysis of Fracture Surface of Ceramics 519
R. HAMMINGER

XPS Characterizations of Ultrafine Si_3N_4 Powders 527
I. BERTÓTI, G. VARSÁNYI, G. MINK, T. SZÉKELY, J. VAIVADS, T. MILLERS AND J. GRABIS

Determination of the Grain Boundary Diffusion Coefficient of Oxygen in Cr_2O_3 531
H. G. SOCKEL, B. SAAL AND M. HEILMAIER

Extended Abstracts

AES Measurements on Poorly Conducting Particles 535
H. JENETT

Microstructure of Fe Implanted Yttria Stabilized Zirconia Studied by Mössbauer Spectroscopy and TEM 536
D. SCHOLTEN, B. A. BOUKAMP AND A. J. BURGGRAAF

SECTION 11. TRIBOLOGY AND WEAR

A Study of the Development of Tribological Oxide Protective Films Mainly by Auger Electron Spectroscopy 541
J. L. SULLIVAN AND S. O. SAIED

SECTION 12. ENVIRONMENTAL

Surface Analysis in Atmospheric Environmental Studies 551
F. ADAMS AND J. DE WAELE

XPS Characterization of Coal Surfaces: Study of Aerial Oxidation of Brown Coals 565
A. R. GONZÁLEZ-ELIPE, A. MARTÍNEZ-ALONSO AND J. M. D. TASCÓN

Extended Abstracts

XPS Characterization of Polymers Used in Heavy Metal Recovery from Wastewaters 573
E. DESIMONI, A. M. SALVI, G. TIRAVANTI AND P. G. ZAMBONIN

Performance and Limitations of a Combined AES/Chemical Deposition Procedure for Trace Element Analysis 574
K. MACHO, R. P. H. GARTEN, D. KLOCKOW AND G. TÖLG

Author Index 577